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Using Nicotine Measurements and Parental Reports to Assess Indoor Air: The Piama Birth Cohort Study

Bert Brunekreef,[1] *Brian P. Leaderer,*[2] *Rob van Strien,*[1] *Marieke Oldenwening,*[1] *Henriette A. Smit,*[3] *Laurens Koopman,*[4] *Marjan Kerkhof,*[5] *and the PIAMA study group*[6]

We used two methods to collect data on indoor smoking exposure of 3-month-old infants. First, parents of approximately 100 children completed a questionnaire. We then measured nicotine in the air of the living rooms in smoking and non-smoking households with a passive sampler for a period of 2 weeks, several months after the questionnaire had been completed. Smoking habits reported in the questionnaire generally with reported number of cigarettes smoked during the measurement weeks, and with nicotine concentrations in the air. These results suggest that exposure classification based on questionnaire data is likely to be reasonably valid. (Epidemiology 2000;11:350–352)

Keywords: questionnaires, validation study, smoking, nicotine measurements, environmental exposures, children, parental smoking

Studies of the effects of environmental tobacco smoke (ETS) on the health of children generally rely on parental reports on home smoking to classify children's exposure.[1] Nafstad *et al* found under-reporting of smoking by parents of children who were 12–36 months old, as assessed from urinary cotinine and hair nicotine measurements.[2] Clark *et al*[3] also found under-reporting of ETS exposure by parents of asthmatic children 5–7 years old, but not by parents of control children. Marbury *et al* found a high correlation between reported indoor smoking and air nicotine levels and, to a lesser extent, urinary cotinine in children who were less than 2 years old.[4] Under-reporting of ETS exposure by parents of study children varies, and may depend on instrument used, population studied, age and symptom status, underlining the need for questionnaire validation in specific study settings.

We conducted a study comparing questionnaire reports of indoor smoking by parents of 3-month-old children to measurement of nicotine in indoor air.[5,6] This study was part of a large birth cohort study in which pregnant women with and without atopy were differentially included. The study is on Prevention and Incidence of Asthma and Mite Allergy (PIAMA). In the study, approximately 1,200 children of atopic mothers, and 2,500 children of non-atopic mothers are being followed from before birth until age 8.

Methods

We distributed questionnaires to all parents when the index children were approximately 3 months old. We asked: "Does smoking take place inside your home?" (yes/yes, but less than once per week/no, seldom or never). We also asked about smoking by the mother, the father, and other household members separately, about the number of cigarettes, cigars, and/or pipes smoked daily inside the home, and about the frequency of smoking in the home by others than household members, with responses categorized as: seldom or never/less than once per week/once per week/more than once per week but not every day/daily.

We then randomly selected approximately equal numbers of smoking and non-smoking households for the validation study. We approached 95 participants, and were successful in visiting 90 of those. One subject had agreed to participate but was not home on the appointment day. Four refused, three of whom were smokers. We measured air nicotine in the 90 homes for 2 weeks during November 1997 – March 1998. The study was introduced to parents as a study on indoor climate and pollution, without referring explicitly to

From the [1]Environmental and Occupational Health Group, Department of Environmental Sciences, Wageningen University and Research Center, and the [2]Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, CT; [3]National Institute of Public Health and the Environment, Bilthoven, [4]Sophia Children's Hospital, Rotterdam, [5]Department of Epidemiology, Groningen University, The Netherlands. [6]Members of the PIAMA study are listed in the Appendix.

Address correspondence to: Bert Brunekreef, Environmental and Occupational Health Group, Department of Environmental Sciences, Wageningen University and Research Center, P.O. Box 238, 6700 AE Wageningen, the Netherlands.

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TABLE 1. Air Nicotine Concentrations in $\mu g/m^3$ in Relation to Number of Cigarettes Reported to Have Been Smoked Daily during the Measurements

No. cigarettes	No. homes	Mean	Range
0	45	<LOD	<LOD–0.20
Occasional	12	0.31	<LOD–1.20
1–5	14	0.86	0.05–4.87
6–10	6	2.34	0.52–4.77
11–15	5	2.80	0.79–4.73
>15	6	5.95	1.34–15.47

nicotine or ETS. After the measurements, participants reported the numbers of cigarettes, cigars, and pipes that household members and visitors had smoked indoors during the measurement period.

We used a passive sampler[7] to measure indoor nicotine. The limit of detection (LOD) for a 2-week sampling period is approximately 0.05 $\mu g/m^3$. Four field blanks showed non-detectable nicotine levels and no correction for field blanks was necessary.

Results

Of the 90 participants, 43 had reported that smoking did not occur in their homes, and 47 reported that cigarette smoking occurred occasionally or regularly. No one reported cigar or pipe smoking. Two participants failed to complete the smoking frequency form at the end of the measurement period, one from each smoking category, leaving 88 participants for the final analysis. In 79 of the 88 responders (90%), there was agreement between indoor smoking reported in the questionnaire and indoor smoking reported during the measurement period.

Table 1 shows air nicotine levels in relation to the reported number of cigarettes smoked daily during the measurement period. There was a monotonous increase in the air nicotine concentrations with the reported number of cigarettes smoked.

Figure 1 shows the air nicotine levels in homes where during the measurement weeks, no smoking had been reported, and in homes where smoking of 5–10 cigarettes per day and >10 cigarettes per day had been reported. Air nicotine levels in non-smoking homes were very low, the highest being 0.20 $\mu g/m^3$, and only 10 of the 45 concentrations being at or above the LOD. Figure 2 shows the distribution of air nicotine levels in homes where according to the questionnaire no smoking occurred, and in homes where 5–10 and >10 cigarettes per day were smoked, respectively. Apart from a 1.20 $\mu g/m^3$ concentration, which was related to smoking at a birthday party during the measurement period, the highest concentration was 0.20 $\mu g/m^3$ in the non-smoking homes, and only 12 of the 42 concentrations were at or above the detection limit.

Discussion

This study shows excellent agreement between regular smoking in the home as reported by parents in a questionnaire, and smoking in the home as reported during a later period of 2 weeks during which air nicotine measurements were conducted. Agreement between reported smoking (either in the questionnaire or during the measurements) and air nicotine concentrations was also good, supporting the validity of the smoking data reported in the questionnaire. Air nicotine concentrations increased in a dose-dependent fashion with the number of cigarettes reported to have been smoked.

We did not collect data on ventilation patterns and air volume of living rooms. Differences in these variables might have contributed to the variation in indoor nicotine levels in the smokers' homes.

Previous studies on the validity of questionnaires on ETS exposure have reported varying results, possibly related to symptom status and age of the children whose parents had been interviewed.[2–4] Our results suggest that

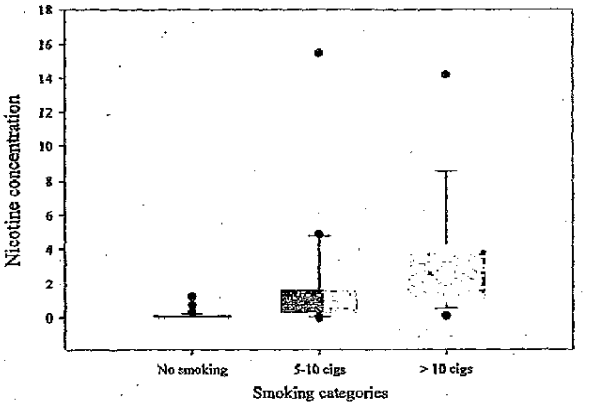

FIGURE 1. Nicotine in air ($\mu g/m^3$) in relation to daily number of cigarettes smoked during measurements. Box demarcates 25th and 75th percentiles. Line in box denotes median. Whiskers denote 10th and 90th percentiles. Dots denote observations below the 10th and above the 90th percentiles.

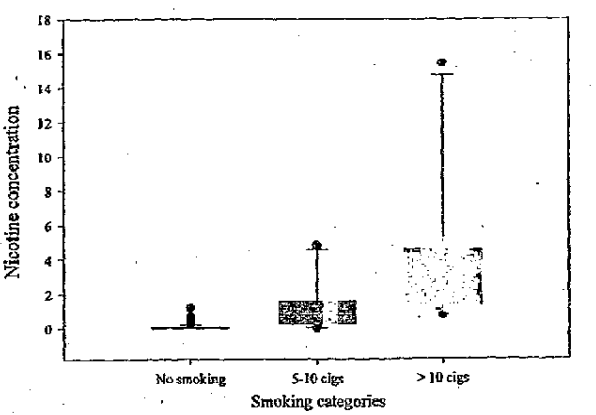

FIGURE 2. Nicotine in air ($\mu g/m^3$) in relation to daily number of cigarettes smoked reported in questionnaire. Box demarcates 25th and 75th percentiles. Line in box denotes median. Whiskers denote 10th and 90th percentiles. Dots denote observations below the 10th and above the 90th percentiles.

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parents of very young children without diagnosed asthma, for the most part, do not under-report smoking in the home.

We conclude that the questionnaire that we have administered to the parents of our index children when they were 3 months of age is a valid and reliable tool to elicit information about ETS exposure of the children in our birth cohort study at that young age.

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Appendix

The PIAMA study is a combined effort of the Wageningen University, the Sophia Children's Hospital of the Rotterdam Medical School (Herman J. Neijens and Johan C. de Jongste), the Beatrix Children's Hospital of the Groningen University Medical School (Jorrit Gerritsen), the Central Laboratory of the Red Cross Blood Transfusion Service (Rob C. Aalberse) and the National Institute of Public Health and the Environment (Henriette A. Smit).

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